



Analysis of Image Stitching for Noisy Images using SIFT

Sarabjeet Kaur

Student, Dept. of Computer Engineering
Punjabi University
Patiala, India

Er. Sumandeep Kaur

Assistant Professor, Dept. of Computer Engineering
Punjabi University
Patiala, India

Abstract: Image stitching is process of stitching different images together so as to get wider field of view as well as retaining as much as information possible. In this paper an attempt is made to stitch the images with different noises. A comparison is done after stitching images with different noises based on simple Image stitching algorithm using SIFT as key point detector. Hence the comparisons are done among different noises to find out how badly images are affected by a particular noise.

Keywords: Image stitching, Noises, Salt and Pepper, Speckle, Gaussian, Poisson, SIFT

I. INTRODUCTION

Image stitching has become most popular field these days be it for scientific interest or real time applications. In order to get a wider view people usually stitch two or more images together. It focuses on removing redundant data and preserve as much as possible information in the image. But the person may come across various problems during stitching of different images. The problems may be related to scale changes, blurring effect, illumination effects or presence of noises.

Image stitching consists of various steps as listed below:

A. Keypoint detection and Matching: Feature detection is used to find correspondences between images in the form of corners, blobs, or edges. There are various detectors used for this purpose. The first one was developed by Hans P. Moravec in 1977 which is considered to be a corner detector. It was further improved by Harris and Stephens by considering the differential of the corner score with respect to direction directly. SIFT and SURF are recent key point detector algorithms. Once a feature has been detected then a descriptor method like SIFT descriptor can be applied to later match them. Various key point descriptors are there such as SIFT (Scale Invariant Feature Transform), SURF (Speed up Robust Features), FREAK and BRISK. SIFT [5] is the older descriptor which is considered best being invariant scale changes or image rotations. SURF is similar to SIFT [4] however it is faster than SIFT [6, 7]. SIFT detects more key points as compared to SURF [2]. BRISK [8] descriptor calculates the weighted Gaussian average of the selected pattern points around the key point. FREAK creates 43 pattern points around the key point. ORB is a binary detector based on BRIEF and FAST.

B. Image Alignment: Alignment helps in transforming an image for matching the view point of the image it is being composited with. It leads to a change in the coordinates system so as to adopt a new coordinate system which outputs image matching the required

viewpoint. The transformations an image may go through are pure translation, pure rotation, and projective transform. Some of the old methods used homography between two images for matching purpose. RANSAC [9] (RANDOM SAMPLE CONSENSUS) a method for alignment is also used as it takes into account consistent data points. It is specially designed to deal with larger number of outliers in the input data.

C. Image Warping: It is an important part of image stitching process. Image warping is the method to manipulate an image digitally such that any shapes portrayed in the image have been significantly distorted [3]. It helps in deforming the images by mapping between images. It may be used for process of correction for the distorted images [10]. Warping consists of two dimensional functions which relate particular position in one image to position in another image. It is very important for compensating image alignment differences.

D. Image Blending: It is used to create a seamless panorama of two dissimilar images [1]. Images are blended together and seam line is adjusted so as to minimize the visibility of seams between images. Blending plays an important role in reducing colour differences as well as hiding the seams.

Now taking noise into consideration there exist various kinds of noises which may be present in the images to be stitched. The presence of any noise may lead to poor stitching of images. Various noises that may be present in images are as:

A. Salt Pepper Noise: This is an impulse type of noise consisting of intensity spikes [11]. This may be occurring due to data transmission errors or due to sharp and sudden changes of image signal. The typical value for pepper noise is 0 and for salt noise it is 255[12]. This generally arises due to malfunctioning of pixel elements in the camera sensors, faulty memory locations or timing errors in the digitization process. The images corrupted with salt and pepper noise can have noisy pixels with only the maximum and the

minimum values in the dynamic range which is taken as 'd' in this paper.

- B. Poisson Noise:** This is also known as shot photon noise which occurs when number of photons sensed by the sensor is not sufficient to provide detectable statistical information [14]. Signal by this noise is corrupted at different proportions [15]. Magnitude of this noise increases as the average magnitude of the current or intensity of the light increases. This noise dominates the darker parts of image. This is the Poisson distribution noise generated from data itself, this can't be added externally like some of other noises.
- C. Gaussian Noise:** This is an amplifier noise which is additive in nature and follows Gaussian distribution. This noise is evenly distributed over signal as each pixel in the noisy image is the sum of the true pixel value and a random Gaussian distributed noise value [13]. The noise is independent of intensity of pixel value at each point. Gaussian noise in digital images may arise during acquisition due to sensor noise caused by poor illumination or high temperature or transmission.
- D. Speckle Noise:** This is called granular noise as it can be modelled by random value multiplications with pixel values of the image and can be expressed as:

$$P = I + n * I. \quad (1)$$

Where 'P' is the speckle noise distribution image, 'I' is the input image and 'n' is the uniform noise image by mean 'm' and variance 'v'.

Hence these are the four major noises that may occur in images. Different types of noises corrupt the images differently making each of them unique. Let us take a look on how a particular noise can affect the images to be stitched and what may be the resultant image whether we get a stitched image or not.

The remaining paper is organised as:

Section 2- provides motivation.

Section 3- depicts methodology.

Section 4-evaluates different results.

Section 5- represents conclusion.

II. MOTIVATION

Image Stitching is one of the major fields for research as well as real time applications. However various challenges are faced for stitching two images. One of such challenge is noise. Noisy images pose a big challenge in today's world. Even trying to avoid any kind of noise a small amount of noise may arise in image that may be due to photon nature of light or thermal energy of heat inside image sensors. Hence noise proves to be biggest challenge when stitching different images. Hence an analysis is done on how different noises affect the images to be stitched.

III. METHODOLOGY

The proposed method consists of simple image stitching process where input is in form of noisy images:

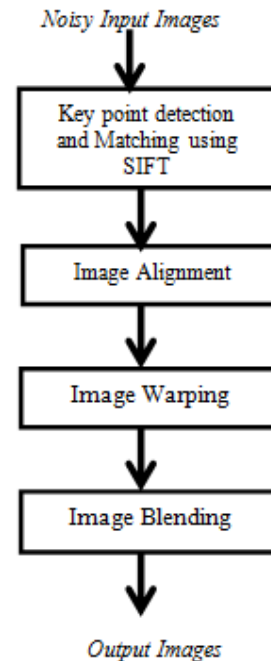


Figure 1: Image stitching Process.

IV. EXPERIMENTAL RESULTS

For the comparison purpose first the images without noise are stitched together and the total key points detected and matched along with time taken for stitching are noted down. Hence following are the results stitching images without noise and farther stitching images with different noises.

Table 1: showing the key points detected and matched without noise.

Images	Key points Detected		Key points Matched	Time Taken
	Image 1	Image 2		
Set 1	4464	4765	1385	0.0014
Set 2	1417	1586	472	0.0009

Above table shows that key points detected and matched as well as time taken for stitching before any kind of noise was present in the images.

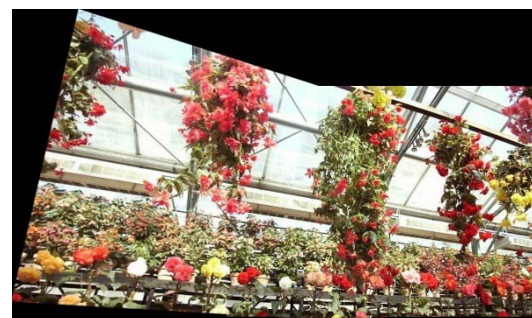


Figure 2: Resultant Image after stitching images without any noise.

Table 2: showing the key points detected and matched with salt and pepper noise.

Images	Value (d)	Key points Detected		Key points Matched	Time Taken
		Image 1	Image 2		
Set 1	0.1	4670	4854	489	0.0005
	0.2	4452	4287	208	0.0041
	0.3	3875	4010	95	0.0010
	0.4	3233	3284	51	0.0056
	0.5	2669	2768	26	0.0022
	0.6	2135	2291	19	0.0006
	0.7	1821	1803	4	Error
Set 2	0.1	2152	2010	91	0.0006
	0.2	2460	2138	35	0.0011
	0.3	2222	1848	30	0.0003
	0.4	1802	1635	19	0.0009
	0.5	1612	1511	9	0.0002
	0.6	1476	1424	4	Error

Above table shows that as the salt and pepper noise increases after certain value the key points matched are not enough and hence the image stitching is not possible.



Figure 3: Resultant Image after stitching images with salt and pepper noise.

Table 3: showing the key points detected and matched with Speckle Noise.

Images	Variance	Key points Detected		Key points Matched	Time Taken
		Image 1	Image 2		
Set 1	0.1	4312	4403	653	0.0008
	0.2	3912	4044	385	0.0006
	0.3	3691	3774	267	0.0004
	0.4	3521	3654	220	0.0008
	0.5	3495	3452	183	0.0002
	0.6	3282	3279	124	0.0039
	0.7	3113	3072	100	0.0009
	0.8	3039	3106	102	0.0008
	0.9	2883	2966	103	0.0008
Set 2	0.1	1848	1925	103	0.0176
	0.2	1934	1977	55	0.0004
	0.3	1908	1830	39	0.0011
	0.4	1876	1844	18	0.0009

0.5	1839	1692	23	0.0002
0.6	1770	1601	15	0.0005
0.7	1767	1654	9	0.0007
0.8	1719	1496	15	0.0007
0.9	1627	1501	13	0.0006

Above table shows that the presence of speckle noise effects the image stitching process to a particular level. Image Stitching is possible even if the noise in the image increases however stitching may not be good enough as compared to images with lower noises.



Figure 4: Resultant Image after stitching images with speckle noise.

Table 4: showing the key points detected and matched with Gaussian noise.

Image	Mean	Key points Detected		Key points Matched	Time Taken
		Image 1	Image 1		
Set 1 Variance=0.5	0.1	2581	2555	26	0.0001
	0.2	2541	2719	28	0.0006
	0.3	2466	2557	31	0.0011
	0.4	2485	2595	29	0.0003
	0.5	2507	2556	27	0.0008
	0.6	2629	2665	25	0.0006
	0.7	2563	2718	27	0.0048
	0.8	2732	2735	24	0.0005
	0.9	2716	2800	15	0.0008
Set 2 Variance=0.1	0.1	1936	1850	46	0.0018
	0.2	1870	1697	37	0.0004
	0.3	1761	1690	34	0.0008
	0.4	1882	1676	28	0.0004
	0.5	1862	1701	26	0.0012
	0.6	1895	1747	17	0.0010
	0.7	1963	1892	20	0.0010
	0.8	2341	2283	10	0.0003
	0.9	2863	3358	13	0.0010

Above table depicts that the key points detected as well as matched are very less as compared to other noises. Hence it can be said that this noise may badly affect the image stitching process.

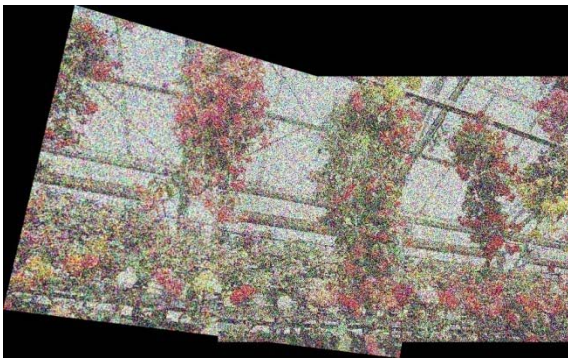


Figure 5: Resultant Image after stitching images with Gaussian noise.

Table 5: showing the key points detected and matched with Poisson Noise.

Images	Key points Detected		Key points Matched	Time Taken
	Image 1	Image 2		
Set 1	4766	5233	1211	0.0004
Set 2	1597	1857	343	0.0012

From the above table it is concluded that Poisson noise least affects the image stitching process, as this noise cannot be added externally but from dataset itself.

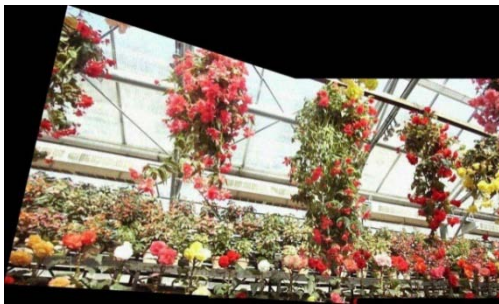


Figure 6: Resultant Image after stitching images with Poisson noise.

On the basis of above results we get the following comparisons.

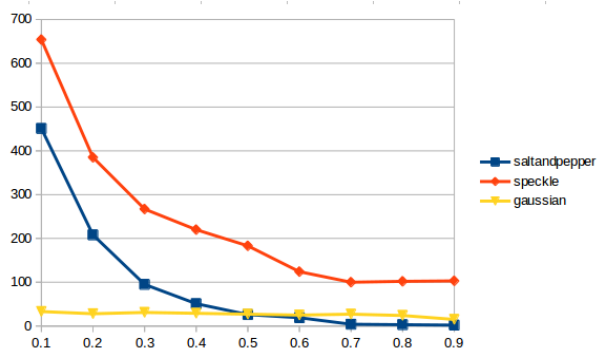


Figure 7: Graph showing key points matched for set 1 in different noisy images.

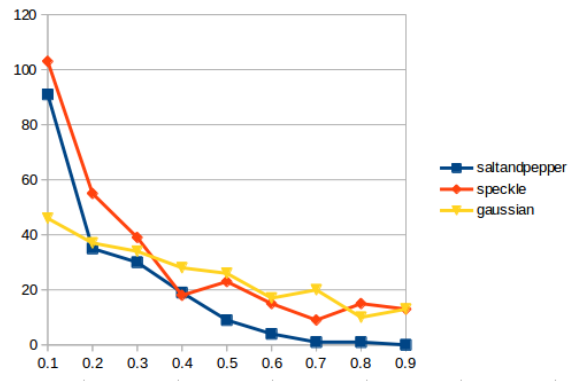


Figure 8: Graph showing key points matched for set 2 in different noisy images.

V. CONCLUSION

This paper applies an image stitching algorithm using SIFT as feature detector on images with different types of noises. Each noise is different from another and behaves uniquely. So, the images with different noises are stitched together and a comparison is done based on the results. The key points detected and matched are more in the images when considered without noise but as soon as noise is entered into images the key point detected reduce so does the key points matched. Hence the Image Stitching is affected. From the experimental results we observed that as the amount of noise in the image increases it becomes difficult to stitch the images. On the account of different noises we observe that the key points matched in Gaussian noise are least and highest in the Poisson noise among the noises taken into consideration. Hence it can be concluded that even the presence of small amount of Gaussian noise in image makes it difficult to stitch the images and the Poisson noise least effects the image stitching.

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